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(71) Applicant *(for all designated States except US)*: ELEKTA INSTRUMENT AB [SE/SE]; P.O. Box 7593, S-103 93 Stockholm (SE).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: HÅKANSSON, Håkan [SE/SE]; Astrakanvägen 6, S-224 56 Lund (SE).

(74) Common Representative: HÅKANSSON, Håkan; Astrakanvägen 6, S-224 56 Lund (SE).

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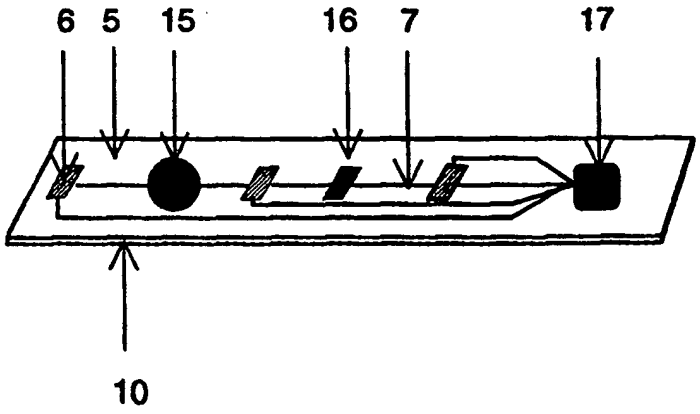
(54) Title: DEVICE FOR DETECTING POSITION OF SURGICAL INSTRUMENTS

(57) Abstract

The invention is a device consisting of a main unit for detecting optical signals and a reference system which detects the position of an operating tool in space as well as its identity. Even if the operation tool is changed during the session the system will detect it. The method comprises a system consisting of a substrate on which light emitting diode chips are mounted. The reference system is connected with a cable to the computerized main unit which feeds the reference system with signals used for detection. The invention can also be made in a battery supplied version. This implies that the system do not need to be galvanically coupled to the main unit.



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Device for detecting position of surgical instruments.

Method for applying infrared LEDs for detection of the position of surgical tools

This technique states:

From the patents US 4,722,056 and WO/92/06645 it is known how to detect an object's position in space by use of CCD cameras that study a number of reference points attached to the object. These references can be objects of different colors or like in WO/92/06645 infrared light emissioning diodes LED. The infrared light has the advantage that it cannot be seen by the human eye and therefore it does not disturb the user.

Especially within the medical technical field this technique has been found useful. For instance, CT- and/or MR- pictures can be filed in a computer and then by help of the localization procedure described above, let a surgical instrument's position in the operation area control the presentation of the constructed data picture that responds to the instrument's position. The disadvantage with the above technique is that special instruments, provided with reference points, must be used. Since a large number of instruments are used during surgery and the individual doctor prefers his own set of instruments, most instruments in the hospital need to be replaced or modified to be usable during operations with a localization system.

The invention described below refers to a device that easily adapts normal surgical instruments to above localization system. Furthermore, it is designed not to affect the instruments used to the same extent as the present systems do. This invention combines technology from semi-conducted manufacturing with the medical technical. See illustrations 1-6 showing different designs of the invention.

Description of Illustrations

Ill 1 describes the complete system consisting of a computer based main unit (1) with belonging detection unit (2) and an indication device (reference system) (3). The detection unit is provided with a filter (4).

Ill 2 describes a reference system (3) with a substrate of glass fiber laminate (5) with conducting pattern (7) on which LEDs (6) have been applied as chips. The system is cable-connected to the equipment. The top side of the device is covered with a LED-translucent plastic material, which also protects the system against solutions and steam which otherwise could affect the functioning of the structure. Underneath a self-adhesive coating is applied.

Ill 3 describes in detail how a LED chip (6) is attached to the substrate (5) and connected with a bonding wire (11) to the printed pattern (7).

Ill 4 describes in detail how a LED in surface mounted design with a substrate (13), outlet (14), LED (6) and protective translucent plastic layer (12).

Ill 5 describes a device, see ill 2 above, completed with a battery unit (15), generator part (16) and an on-off switch for the battery power. This supplement makes the equipment possible to use without having it connected by cable to the rest of the system (1).

Ill 6 shows a practical example where the reference unit (3) is attached to an electrode (20) for electro stimulation. By using the reference unit the position of the electrode's point (18) can be set.

Description of the invention

The invention described below is applicable within the medical technical field and especially within surgery.

The whole system consists of :

- a main system connected to two or more cameras usually of CCD type
- a hand-held instrument (cable-connected to the main unit) on which identification devices are attached.

These identification devices could for example consist of LEDs, preferably emissioning radiation in the infrared range (700-1200 nm). The advantage of using the infrared light as communication is that it is beyond the visible range (400-700nm) and therefore the operator will not be disturbed by the emitted light and that all other visible light in the surroundings can be filtrated and will therefore not interfere with the transmission of information from the instrument to the detecting equipment.

Several different methods can be used to detect which specific instrument is connected to the system. You can for example use the physical distances between the diodes or by allowing the diodes to emit the light pulses of different pulse frequency, pulse form or wave for identification. Even if the instrument is exchanged during operation the system can reveal that an exchange has taken place and consider this at calculations and presentations.

The identification arrangement can be made as a fixed pattern of light diodes attached on a preferably stiff carrier which allows that different types can be supplied with the identification arrangement.

Ill 1 describes the total system with the reference system (3) and the detectors (2) connected to the central unit (1) where the built-in computer calculation of the references' positions takes place. A filter (4) is placed in front of the detectors which screens off the visible light but allows the light from the reference points to pass.

Example of performance (see ill 2)

Light diode chips (6) are glued with conducting epoxy glue on a carrier of glass fiber laminate (5) and on the top there is a pattern (7) etched in copper. One of the diode's contact points has in this example been connected to a mutual conductor while the diode's other contact point by means of bonding technique (see figure 3) has been connected to separate conductors to allow the diodes to be activated independently from each other. From the carrier laminate (5) there is a cable to the central unit (1) from where the power is received. The cable is supported by an enforcement strap (9) to withstand higher loads. The top surface of the indicator is covered with a plastic coating, which is translucent for the emitted light, to protect the diodes from mechanical wear and galvanic isolation of the electric parts of the system. Underneath the carrier material there is a self-adhesive surface coating for attaching the surgical instrument (10).

As an alternative to the light diode chip (6) that is attached directly to the laminate, (5) light diodes meant for surface attachment can be used, se ill 4. In this design the light diode chip is attached to a substrate (13) with two contact points (14) for external connection. The chip (6) with its bonding wire (11) is protected by an epoxy glue coating (12). The component is attached by welding or conducting glue directly to the conductors (7) on the laminate (5). Typical size of these components is length 3 mm, width 1,3 mm and height 1,2 mm.

Example of performance 2 (ill 5)

In this example aluminum oxide, which is a ceramic material, has been chosen as carrying material (5). The wiring (7) is in this design silver epoxy conductor printed by means of thick film technique onto which light diode elements (6) are glued with conducting glue. In this example the unit (3) also has been supplied with a lithium battery (15) which can be switched on-/off (17). The system also includes a generator (16), which can supply the different light diodes (6) with for each of them a characteristic pulse frequency, to make the reference system (3) coded. This results in that the central unit (1) via the detector unit (2) can determine which individual reference system has sent the signal. The entire system is kept in a tight plastic cover which gives protection to surrounding fluids but lets the emitted light through.

Example of performance (see ill 6)

In this example the reference system (3) is applied to a stimulating electrode (20) which via the cable (21) is connected to a stimulating generator. The electrode is furnished with a handle on which the reference system (3) is attached. The point of the electrode (18) is electrically conducted while the connection tube (19) is electrically isolated. The point's position can be indicated by the reference system, thus for instance by submitting the coordinates position to an imaging system a presentation of the point's position in comparison with earlier X-ray pictures can be made like in US 4,722,056.

For an expert it is obvious that the above examples only present a few of the combinations that can be used and makes use of the invention. For instance the self-adhesive coating as attachment for the surgical instrument might as well be replaced by different kinds of clips.

Patent demands:

1. Device for identifying the position of surgical instruments including a control system, main system, central system, with at least two optical detectors for receiving signals from a reference arrangement with at least two identifying points characterized by that they are light emitting diode chips and attached to a stiff substrate of such material that the distance between the diodes is kept constant.

2. Device according to demand 1 characterized by the substrate is of non-conducting plastic material preferably glass fiber plastic.

3. Device according to demand 1 characterized by the substrate to be made of ceramic material such as aluminum oxide.

4. Device according to demand 1 characterized by the conducting pattern is produced by printing and/or etching.

5. Device according to demand 1 characterized by the light diodes are emitting in the infrared range.

6. Device according to demand 1 characterized by that the back of the substrate is furnished with self-adhesive material for attaching the surgical instruments.

7. Device according to demand 1-6 characterized by that the equipment is also furnished with a generator part and power supplied by a battery attached to the substrate.

8. Device according to demand 1-6 characterized by that the detectors in the main system are furnished with a filter to filtrate visible light.

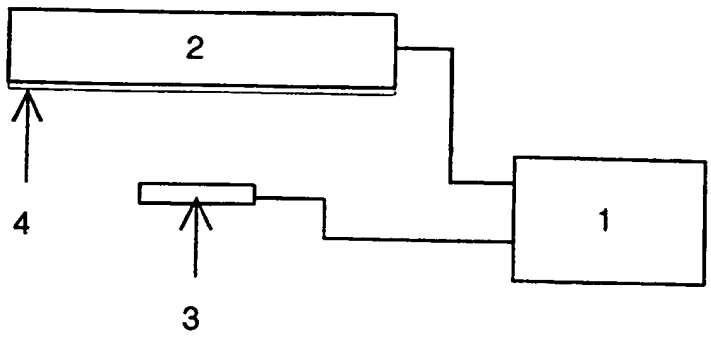

Fig. 1

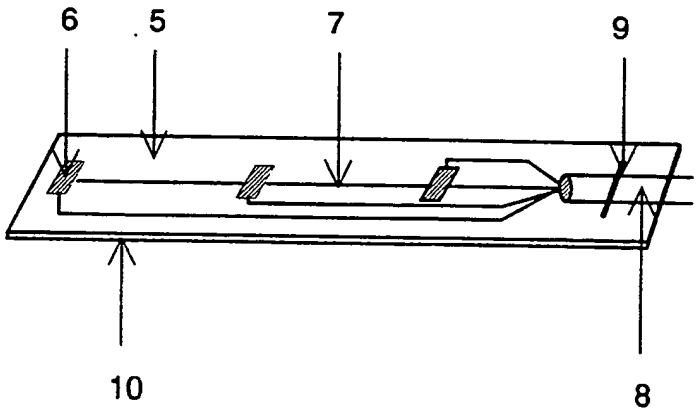

Fig 2

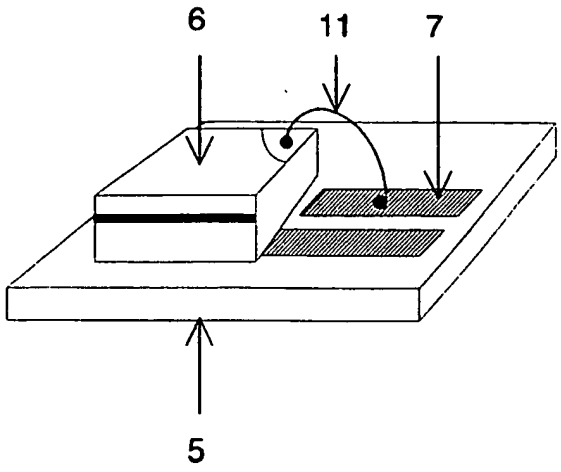

Fig 3

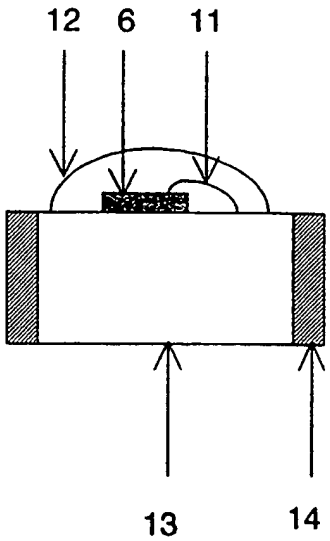

Fig 4

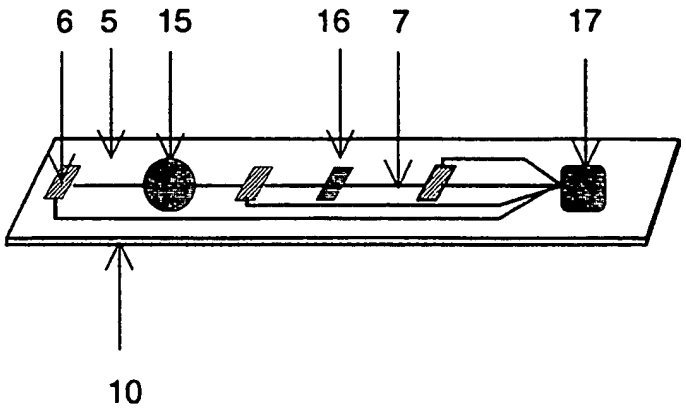

Fig 5

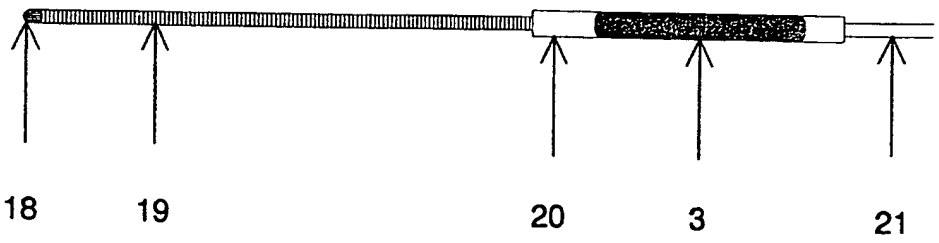

Fig 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 95/00286

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A61B 19/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC6: A61B, B25J, G01B, G01C, G01D, G01S, G06F, G06K, G08C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP, A2, 0456103 (INTERNATIONAL BUSINESS MACHINES CORPORATION), 13 November 1991 (13.11.91), column 4, line 50 - line 58; column 5, line 13 - line 21, figure 1 --	1-8
X	DE, A1, 4202505 (FA. CARL ZEISS), 5 August 1993 (05.08.93), column 2, line 20 - line 49 --	1-8
A	EP, A1, 0427358 (ALLEN, GEORGE S.), 15 May 1991 (15.05.91), abstract --	1-8

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP, A1, 0114505 (DIFFRACTO LTD.), 1 August 1984 (01.08.84), page 5, line 13 - line 18; page 6, line 6 - line 10	1-8

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INTERNATIONAL SEARCH REPORT

03/05/95

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0456103	13/11/91	JP-A- 4231034	19/08/92
		US-A- 5086401	04/02/92
		US-A- 5299288	29/03/94
DE-A1- 4202505	05/08/93	US-A- 5345087	06/09/94
EP-A1- 0427358	15/05/91	AU-B- 632633	07/01/93
		AU-A- 2745192	17/12/92
		AU-A- 6590790	16/05/91
		CA-A,A- 2029401	09/05/91
		EP-A- 0647428	12/04/95
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